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# USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

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30 November 1984

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UDC 621.371.396.25

RESEARCH ON PROPAGATION OF DECIMETRIC RADIO WAVES AT HIGH LATITUDES

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 27 Sep 83)  
pp 39-41

TROITSKIY, V. N.

[Abstract] In order during Polar summers to study anomalously high signal values affecting radio propagation, in the summer of 1980 research was conducted on decimetric waves over a sea path of 433 km, using antennas with gains of 44 and 46.2 dB, and over a 357-km tundra and woodland path using 46.2 dB gain antennas. In order to evaluate the signals an attenuation factor was used consisting of a ratio of the observed signal to free space reference signals which shows possible antenna losses. Fluctuations and levels were plotted for the indicator. Comparison with meteorological data showed that anomalously high levels are caused by nonuniformities in the refractive index of the lower troposphere which acts as a waveguide when temperature inversions caused by continent-sea air movements occur. Amplitude fluctuations are caused by waveguide changes and interference phenomena. The results of the method utilizing attenuation factor statistics are considered better than those of the International Radio Consultative Committee (CCIR). Figures 4; tables 3; references: 2 Western.  
[297-12497]

UDC 621.396.67:621.391.812

ONE-CHANNEL ADAPTIVE ANTENNA FOR TROPOSPHERE MICROWAVE RELAY LINES

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 22 Sep 82)  
pp 28-31

FROLOV, O. P. and TSIRLIN, V. M.

[Abstract] Adaptive antennas improve the performance of troposphere microwave relay lines (TMRL) by reducing fading and eliminating competing signals. The signal steadiness gain is equivalent to an increase in the number of channels and grows with antenna aperture. A horn system containing adjustable gaps is considered with regulation by microprocessor control of the input signal, which is digitized and compared with reference values. The signal processing algorithm uses a linear relation for the criteria which is not always satisfied and can lead to errors. In April 1981 experiments were made with a one-channel antenna coupled to a TMRL with a relay path of 389 km, an antenna power of 43 dB and an aperture of 20 x 20 m<sup>2</sup>. The horn contained 64 controllable elements. The results showed that for low signal levels the gain was a factor of 2, the noise reduction for a one-component signal in comparison with a simple relay was 5-7 dB, the gain for a three-component signal was 3-4 dB, and interference elimination amounted to 4-8 dB. It is concluded that adaptive antennas should be used on TMRL. Protection of control elements against high transmitter power levels should be studied. Figures 5; references: 5 Russian.  
[297-12497]

UDC 778.5(47+57)

SURVEY OF MAIN ACHIEVEMENTS IN ENGINEERING OF PROFESSIONAL CINEMATOGRAPHY  
IN 1983

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 5, May 84 pp 3-25

BONDARCHUK, V. M. and IRZ, P. V., TsKBK (Central Design Office for Cinematography), GILINSKIY, A. G. and DROZDOV, V. M., NPO "Ekran" ("Screen" Scientific-Industrial Association), participated in the survey as well as TsOONTU NIKFI (Central Department, Joint Scientific-Technical Publishing House--Scientific Research Institute of Cinematography) and co-workers of the institute, GOLOSTENOV, G. A., GORELOV, Ye. P., KOVALEVSKAYA, N. S., KRIVOVYAZ, A. L., KUSHNAREV, V. K., NEVEROVSKIY, K. V., OVSYANNIKOVA, N. A., POKHITONOV, Yu. P., RESHETNIKOV, V. N., TARASENKO, L. G. and KHAKHILEVA, G. S.

[Abstract] The year 1983 has witnessed several engineering achievements in the field of professional cinematography. Those which pertain to film shooting apparatus include completion of the "Kinor 35S" (5KSN) portable 35 mm film camera with televisor and remote optics control, refinement of rules for production of stereoscopic films, completion of 1KPU-1.5-12 and 1KPU-8-16 standard hermetic power supplies with NiCd cells, modernization of 70SKN-D camera for nature films, development of the 17EP-16APK electric motor to replace the existing 15EPSS electric motor, with easier speed switching, higher torque, quartz-oscillator speed stabilization, and plastic housing suitable for operation at subzero temperatures, construction of the 2TOR trolley with set of rails, development of the TsU-01 quick-motion shooting device, and development of the PKPP-1 monitor of film positioning within the camera frame. Those which pertain to camera optics include spherical and anamorphous attachments for the 350PF18-1 variable-focus objective, and development of the DKO-1 test projector for quality control of camera objectives. Those which pertain to lighting include production of series DRISH 200-7000 W metal-halide lamps with a rare-earth additive, completion of "Spektr-200" and "Spektr-1200" luminaires, and development of original PN-1 intensifiers for nature filming. Those which pertain to sound recording and playback include modernization of the F4286 digital delay line, development of 38LIMZ-UP and 35LIMZ-Sh-23 magnetic tapes for sound track inspection and measurements, development of KMK-45 capacitive microphone, factory approval of KZF-7 photographic phonogram recording set and KZFT-5 35/2x16 mm monitor-film recording set. Those which pertain to film projecting apparatus include production of DKsSh 3 kW ozone-free xenon lamps with film coating, development of 35KP-1.6/65 and 35KP-1.6/140

fast objectives, modernization of "Chernomorets-1A" 16 mm projector rack with standard A221A attachment and with several bifilar cartridges for long footage, also suitable with "Raduga-2" or "Ukraine-5" projectors, and development of Al61A 2x16 mm stationary projector. Accessories include the A732A film splicing table, the 47P-9 black-and-white film developer with all necessary chemical-photographic treatment facilities, and two original monitor films for checking the image resolution: 35ShE-KFMO-35 and 70KFMK, the latter for use in contact printing. Figures 27; tables 3.  
[311-2415]

UDC 621.039.514.25

#### HYBRID COMMUTATION IN SUPERCONDUCTING CRYOTRON CONVERTERS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 5, May 84 (manuscript received 25 Mar 81) pp 20-24

ANTONOV, YURIY FEDOROVICH, candidate of technical sciences, senior scientific research worker, and MIKUTSKIY, ALEKSANDR STANISLAVOVICH, senior engineer, VNIIElektromash (probable expansion is All-Union Scientific-Research Institute of Electrical Machine Construction), Leningrad

[Abstract] Hybrid resistance-inductance commutation in superconducting cryotron converters under high load currents is analyzed, considering that this cyclic transient process involves a superposition of two modes with either one of them dominant but not exclusively during the various periods. A commutation cycle is appropriately subdivided into two stages of current buildup in the shorted coil and two stages of current transfer to the next coil. Calculations, shown here for a single-phase converter with a neutral center tap, are based on an equivalent circuit which includes not only two loops representing successive coils on the secondary side but also one loop across the two representing the primary. The corresponding systems of differential equations for each period of the commutation cycle are solved for current amplitude (assuming a quasi-steady state), power loss, and duration of that period. The coefficients in these equations, which combine self- and mutual inductances and resistances, are determined under the assumption that both secondary coils are identical. Figures 2; references 4: 2 Russian, 2 Western.  
[308-2415]

## PROTECTION OF UNDERGROUND COMMUNICATION CABLES

Moscow VESTNIK SVYAZI in Russian No 6, Jun 84 pp 32-33

LAKERNIK, R. M., candidate of technical sciences, laboratory chief, "Moskabel'" Industrial Association, laureate of State Prizes, and FOMIN, K. P., engineer, "Giprosvyaz'" (State Institute for the Surveying and Planning of Communications Installations)

[Abstract] The use of aluminum or steel instead of lead as a sheathing material for underground communication cables, with anticorrosive plastic or rubber sleeving, eliminates the need for armor and thus reduces cable manufacturing cost as well as cable installation cost. It also increases the vulnerability of cables to damage. However, the greatest danger comes from rodents. Scientific field studies of rodent population distribution in various regions of the USSR confirm that the hazard is greatest in woody and forest terrain, although it is almost nil in desert and semidesert terrain. Small carnivores such as foxes and badgers are found not to present any danger at all. Laboratory studies reveal that, contrary to previously accepted hypotheses, rodents gnaw not only aromatic polymers such as polyvinyl chloride but also aliphatic ones such as polyethylene and even lead too and that they do not use shreds of insulation for furnishing their dens. They do, however, gnaw insulation to sharpen and grind down their growing teeth as well as to clear obstacles along their path. It has been possible, on the basis of these studies, to recommend protective measures. They include ensuring adequate hardness of the insulation material, at least 3 on the Mohs scale, and installing cables sufficiently deep below the surface - the probability of attack by rodents and thus the frequency of faults decreasing exponentially with increasing depth. The cable size is an important factor, inasmuch as the diameter over the insulation compares with the clearance between a rodent's incisors in open jaws. Accordingly, protective armor is recommended for cables of a diameter smaller than 20 mm and armor can be omitted on cables larger than that. Special precautions are necessary in terrains covered with woods and forests, compacting of the soil being an effective method of barring rodents.

[309-2415]

## FOURTH STAGE OF MODERNIZATION OF TELEVISION RADIO STATION

Moscow VESTNIK SVYAZI in Russian No 6, Jun 84 pp 36-37

FRIDMAN, E. M., chief, Central Laboratory, ORPS (probably All-Union Radio Television Station imeni 50 years of October), SHELEPEN', I. V., chief specialist, and KOROTYCHEV, V. I., senior engineer

[Abstract] A major aspect of the overall modernization program in radio television stations, to facilitate step-by-step automation and to improve the reliability, is "transistorization" of the operating channels. The main problem encountered here is unavailability of VHF power transistors with

sufficiently high gain, which are needed for constructing 70-80 W single-cycle channels with the minimum number of stages without use of intricate and unwieldy power summation circuits. Another problem lies in the complexity of transistor circuits, which is inherently greater than that of vacuum-tube circuits. Staffs of the Central Laboratory, ORPS and of the RPTML RURT [expansion unknown. In a list of abbreviations, RURT is expanded as "Rayon Administration of River Transportation."] at the UkSSR Ministry of Communications have during the fourth stage of this modernization program jointly developed an experimental radiofrequency channel for the "Yakor'" radio television station. The channel consists of eight transistor stages including an amplitude limiter, a frequency multiplier, a preamplifier, a modulator with suppression feedback, and an output stage. The base of the amplifier-limiter transistor receives the high-frequency signal from a reference vacuum-tube oscillator. The triple-frequency video carrier signal is amplified and then modulated in the base of the modulator transistor, while the sideband components are suppressed. The feedback loop contains a detector, a pulse shaper, three operational amplifiers, an emitter follower, and transistor switches. This channel combines simplicity of construction with simplicity of tuning, contains no scarce components and adjusting devices, and it is sufficiently versatile to be easily adaptable to video and audio channels in various "Yakor'" and "Uragan" stations. Figures 4. [309-2415]

UDC 778.55(47+57)

# ADVANCE SERIES OF MOTION PICTURE PROJECTING APPARATUS FOR CINEMA NETWORK

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 6, Jun 84 pp 29-35

LARIONOV, L. G., All-Union Scientific Research Institute of Cinematography

[Abstract] Design and performance characteristics of modern motion picture projectors for cinema theaters are discussed, with the international norms adopted by the Soviet motion picture industry in 1977 as point of reference. Using the luminance of the screen  $L = 40^{+25}_{-15}$  cd/m<sup>2</sup> as the fundamental parameter, a simple relation has been established for the necessary luminous flux from a projector  $\phi = \eta_3 LN$  ( $N$ - seating capacity,  $\eta$ - coefficient depending on the ratio of film frame sides). There also exist simple relations for the length of the theater hall  $D = k_1 \sqrt{N}$  and for the width of the screen  $W = k_2 D$  (coefficients  $k_1$  and  $k_2$  depending on the theater layout and on the type of motion picture show). These relations, applicable to 16 mm and 35 mm films, are also extended to cover 70 mm films and are evaluated for the purpose of establishing projector design and production criteria. Production goals must be based on application data pertaining to size and number of cinema theaters. The latter range from large ones in cities to small ones in villages, and their operation ranges from continuous to part-time, seasonal, and special in schools or nurseries. On the basis of technical criteria and user statistics 5 classes are now proposed of motion picture projectors overlapping with 10 sizes of lamps in order to cover the entire cinema market, specifically

for showing of 35 mm and 70 mm films. All accessories are allowed to be classified and standardized optionally. A survey of available light sources indicates a need to accelerate the production of xenon lamps, including 6-6.5 kW sizes, for horizontal mounting. Figures 4; tables 3; references 6: 5 Russian, 1 Western.  
[311-2415]

UDC 778.534.4

SOME FEATURES OF RESTORATION OF SOUND SIGNAL BY MEANS OF ITS ENVELOPE AND INSTANTANEOUS FREQUENCY

Moscow TEKHNKA KINO I TELEVIDENIYA in Russian No 6, Jun 84 pp 35-37

ISHUTKIN, Yu. M., Leningrad Institute of Motion Picture Engineers

[Abstract] Restoration of a sound signal is treated as synthesis of a real signal  $s_m(t)$  on the basis of its modulation characteristics, specifically its envelope  $S(t)$  and instantaneous frequency  $\omega(t)$ . Physical realization of an orthogonal complementary reference signal is not required here, but becomes necessary for analysis and evaluation of the synthesizer performance. The synthesizer consists of a modulator, where a generally arbitrary orthogonal reference signal added to the real signal produces a complex one, followed by a low-pass filter and then a demodulator. While the choice of reference signal for modulation analysis is free in accordance with an "input" procedure yielding any desired modulation function, the choice for modulation synthesis is restricted to a signal which will complement the real signal to a specific set of modulation characteristics constituting the "input" with respect to the modulation operator  $\text{mod}(S, \omega)$ . With the aid of a lemma pertaining to bounded variation and bounded derivatives of both  $s_m(t)$  and  $S(t)$  on a finite time interval, it is demonstrated that the reference signal will be related to the real signal through the homogeneous Hilbert operator and that the restored signal will be a linear combination of both with a weight factor each. According to these two theorems, only a Hilbert analyzer will extract given modulation functions from a synthesized real signal. References:  
4 Russian.  
[311-2415]

## FUNCTIONAL THRESHOLDS OF PRECISION AND PARAMETRIC RELIABILITY FOR TAPE TRANSPORT MECHANISMS

Moscow TEKHNKA KINO I TELEVIDENIYA in Russian No 6, Jun 84 pp 38-40

KOLOMENSKIY, N. N., Leningrad Institute of Motion Picture Engineers

[Abstract] A threshold criterion of functional precision and parametric reliability is proposed for evaluation of cinematographic tape transport mechanisms, in order to replace the inadequate conventional double standard deviation and maximum or peak deviation characterizing rms and uniform approximations, respectively. The probabilistic characteristics of overshoots of random functions beyond a generally n-dimensional interval is more informative with regard to psychophysiological perception of distortions and noise in image or sound signals. This criterion takes into account both random and deterministic components of the process, without being restrictive and applicable to the worst case only. The relevant statistical characteristics of overshoots are, in addition to mathematical expectation and dispersion, also probability densities of the number of overshoots, their duration and amplitude within a unit of time. In accordance with this criterion is established a correspondence between sensory threshold of the human eye or ear and precision or reliability of the transport mechanism with respect to tape position and tape movement. On the basis of this correspondence precision and reliability requirements are then established for tape transport mechanisms, taking into consideration the diversity of equipment in terms of rating as well as the economic factor in terms of the cost function. The latter is arbitrarily approximated as

$$A = \alpha \log \left( \frac{1-P_0}{1-P_r} \right) \quad (\alpha - \text{specific cost of reliability increment by}$$

design or in service,  $P_0$  - known initial attainable reliability,  $P_r$  - sought ultimate required reliability). References: 7 Russian.

[311-2415]

UDC 621.373.13:621.397.13

## SAWTOOTH-VOLTAGE GENERATORS FOR ADAPTIVE TELEVISION SYSTEMS

Moscow TEKHNKA KINO I TELEVIDENIYA in Russian No 6, Jun 84 pp 45-48

ROSATKEVICH, G. K.

[Abstract] The sweep generator in a television system is an adjustable-amplitude, adjustable-frequency sawtooth-voltage generator connected directly or through a decoupling capacitor to an adder, the latter with a centering voltage applied to its other input and with its output connected to a linear power amplifier feeding the vertical deflection plates. Modern technology has made it feasible to build high-quality sawtooth-voltage generators using



operational amplifiers with negative feedback as integrators. It has also made it feasible to replace the capacitor, which degrades the performance by introducing nonlinearity and leakage as well as by lengthening the response time and adding a source of instability for the d.c. voltage component. Two versions of a sawtooth-voltage generator without these deficiencies for use in adaptive television systems are described, one with a discharge switch and one with a discharge-current stabilizer, both fully "transistorized", Figures 2; references: 9 Russian.  
[311-2415]

UDC 778.533.6-83

#### ELECTRIC DRIVE FOR PROFESSIONAL MOTION PICTURE CAMERA

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 6, Jun 84 pp 54-58

ABAKUMOV, V. G., VRZHESENEVSKIY, Ya. V., MIROSHNIKOV, A. I., PRYADKO, A. M. and KHALYAPIN, V. V., Motion Picture Studio imeni A. P. Dovzhenko; Moscow Motion-Picture Equipment Plant.

[Abstract] Electronic speed synchronization and stabilization circuitry has been developed for redesign of existing electric drives used in professional motion pictures. Such a redesign, specifically targeted for "Konvas" and "Kinor" cameras used in the "Salyut-7" space probe, involves mass and size reduction without degradation of performance and within economic constraints. This circuitry, applicable to a DPR-72 d.c. motor with a base torque rating of 12 N·cm and operating either from a 10-24 V storage battery or from an a.c. line through a converter, consists of a quartz-crystal oscillator for frequency stabilization within  $2 \cdot 10^{-4}\%$ , a reference-frequency oscillator, a frequency divider for a speed of 24 frames/s, a frequency-phase discriminator, a shaper of square pulses with time delay for the true-speed signal, a power amplifier, a supply-voltage stabilizer, and two light-emitting diodes for synchronism and voltage level indication, respectively. Optional auxiliaries include another frequency divider for a speed of 25 frames/s, a line synchronizer, and a variable-speed module. The circuitry is designed to fit into an 18EP-16APK or 23P-16APK housing, with the chassis also carrying radiators of the power transistors in addition to optical components such as the magnifier with mirror and the objective with shutter, and with a printed-circuit terminal board for all motor, supply, and stabilizer connections. The multiconductor cable connecting the motor to the control module has been eliminated. Figures 7; references: 4 Russian.  
[311-2415]

## HIGH-SENSITIVITY IMAGERS FOR COLOR-TELEVISION CAMERAS

Moscow TEKNIKA KINO I TELEVIDENIYA in Russian No 6, Jun 84 pp 59-67

KURKOV, I. N. and MILENIN, N. K.

[Abstract] Modern foreign-made imagers with high sensitivity for color-television cameras include: 1) Westinghouse "secon" and Japanese NHK "proxicon" transmitters with alkali-metal photocathode and porous target, based on secondary electron conduction; 2) RCA "silicon intensifier" transmitter with S-20 photocathode and mosaical target, based on preswitching amplification; 3) optoelectronic converters VARO "saticon" with electrostatic focusing and NKH (Japan) or PROXITRONIK (FRG) "proxifiers" with near-field focusing. Broadcasting color-television cameras have been designed and built with various combinations of imagers, such as one using three "saticons", one using three "silicon intensifiers", and a hybrid one using three "saticons" coupled to optoelectronic converter arrays. The sensitivity of color-television cameras can be further increased through reduction of the preamplifier noise, most effective being replacement of ring-type current pickups with face-type ones, which will reduce the input capacitance, and use of higher-grade field-effect transistors. Other improvements such as smaller and more uniform dark current are attainable by cooling the array of charge-coupled devices, possibly utilizing the Peltier thermoelectric effect. This method requires additional space and power, however, and preference is therefore given to improvement of the room-temperature characteristics of that array. Figures 15; tables 2; references 26: 8 Russian, 18 Western (1 in Russian translation).

[311-2415]

UDC 621.391

## ADDRESS-CODE ASYNCHRONOUS SWITCHING AND MULTIPLEXING OF COMMUNICATION CHANNELS

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 29 Jun 82) pp 14-18

KHALIN, F. M.

[Abstract] Integrated digital networks require improved switching and several methods exist for specific purposes (telephone, telegraph, data processing, etc.). A switching method is proposed based upon address-coding utilizing statistically-based multiplexing for transmission of voice signals, large data volumes and conversation mode signals and interactive data in data packet mode which is also useful for service signals. A first variant of the method involves discrimination of the location of the front of the pulse train while a second variant utilizes bunching of the signals and differs from packet switching in that addresses are assigned to channels in

accord with operational loads and characteristics. Variant 1 for telephone, telegraph and other uses has good transmission characteristics with redundancy compensated by channel group multiplexing. In order to increase channel utilization, load and flow ratios are usually evaluated and a third channel activity criterium is developed for establishing the presence of digital pulses in a determined time interval. The economical coding method makes it possible to increase the transmission capacity of the communication lines. Figures 3; references 11: 8 Russian, 3 Western.  
[297-12497]

UDC 621.315.2:621.39.015

#### PULSE DIELECTRIC STRENGTH OF KM-8/6 CABLE AMPLIFIER SECTION INSULATION

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 5 Mar 82)  
pp 19-21

KALININ, N. D. and MIROSHNICHENKO, V. K.

[Abstract] The establishment of a correct maximum permissible pulse breakdown voltage for cable insulation is necessary for effective use. Low values mean unnecessary costs while high values mean an increased possibility of insulation breakdown and failure. The pulse dielectric strength of the KM-8/6 cable was studied and values were established separately for coaxial components which are affected when lightning strikes. In order to evaluate the effect of cable sleeves, the insulation effectiveness of 16-meter pieces was compared with that of lengths assembled with sleeves. Results showed that minimum pulse breakdown voltages are 25% lower with sleeves which was caused by deformation of the polyethylene shell insulation occurring during the assembly process. Computations showed that the effect of the sleeves on cable dielectric strength was insignificant and the maximum permissible breakdown voltage of the amplifier section of the system can be used as the cable value. The results for breakdown probabilities 0.01 and 0.001 were higher than the current standard value of 3.6 kV. Tables 3; references: 3 Russian.  
[297-12497]

## LIGHTNING DISCHARGE DENSITY TO GROUND AND CABLE STORM DAMAGEABILITY

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 31 Dec 81)  
pp 21-23

KRECHETOV, A. A. and SAPOZHNIKOV, V. M.

[Abstract] Cable vulnerability to lightning is determined by various meteorological geophysical and terrain features which vary greatly with more than 50% of cable damage occurring in permafrost and high resistivity soils. In order to develop a method for vulnerability evaluation, lightning discharge density was selected as a criterium as measured by the number of damaged trees in an area. A photographic atlas was created for the area of the TTsUMS-12 line and for the period 1974-1980 the number of lightning bolts within 100 m of the cable over 162.8 km were determined and vertical sections were investigated in relation to specific resistivity. It was possible to identify the most vulnerable zones which were linked to weakly conductive strata and bolts were dated by dendrochronology. A link was established between cable vulnerability and discharge density and statistical treatment can show local vulnerability. Figures 2; tables 1; references 8: 5 Russian, 3 Western.  
[297-12497]

## EFFECT OF DEFORMATION ON BALANCED CABLE ELECTRIC PARAMETERS

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 30 Sep 82)  
pp 24-25

YESERKEGENOV, A. S.

[Abstract] Mechanical deformation has significant effects on cables in difficult geographical areas (swamps, permafrost, etc.) and subjected to diverse soil conditions. Type MGSG (7x4x1.2) and MKSB (4x4x1.2) cables were tested by no-load and short circuit methods in order to evaluate the effects of radial deformation on electrical characteristics. It was found that resistivity, inductivity and damping coefficients differed from theoretical values by less than 4-5% while capacitance differed by 15-26% because of changes in dielectric permittivity caused by deformation. For deformations of the transverse section exceeding 15%, cable conductor interaction worsened which reduced multiplex effectiveness. Strengthening and armoring are recommended. Figures 4; references: 4 Russian.  
[297-12497]

## ELECTROMAGNETIC TIME CHARACTERISTICS FOR HOMOGENEOUS SCREEN PULSE TRANSMISSION

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 6 May 83)  
pp 25-27

KOLESNIKOV, V. A. and SIDNEV, S. A.

[Abstract] Screening is used to protect cable circuits but the effects of different pulse shapes have not been adequately studied, although they affect the transmission of digital data. A method is developed for determining time characteristics for pulses affecting shielded circuits which depend upon pulse shape (exponential, triangular, bell-shaped) and the transient characteristics of the shield. Computations were made showing variations in the different pulses and indicating that passage through the screen increases the length and decreases the amplitude of the pulse. Figures 3; references: 4 Russian.  
[297-12497]

## MICROWAVE SINGLE-BAND MODULATOR

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 27 Jul 83)  
pp 54-56

VOROB'YEVSKIY, Ye. M., GVOZDEV, V. I. and LITVINENKO, M. Yu.

[Abstract] Microwave modulators encounter problems caused by insufficient suppression of the carrier and one sideband and conversion losses in the other sideband. A hybrid bridge design is proposed consisting of dielectric and metal layers with the signal entering a coupler and then passing through the bridge structure with output into a summator. The design has good technical qualities because, except for semiconductor diodes, it consists of metal films assembled in a single operation while base gaps do not require very high precision processing. The modulator was tested in the long-wave part of the centimeter range. A 1-mm thick FLAN-10 base was used with KA117 BR-6 diodes. A carrier wave of 1-mW with a 0.85 V sine signal was used and the carrier suppression in relation to the lower sideband was 23-30 dB and in relation to the upper, 18-23 dB. The unit is recommended for transmission lines and design facilitates use up to the millimeter range. Figures 2; references 7: 5 Russian, 2 Western (1 in Russian translation).  
[297-12497]

COAXIAL SWITCH

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 26 Nov 82)  
pp 37-38

ANTONENKO, V. M., BERLYAVSKIY, I. Z. and CHUBIS, V. I.

[Abstract] Superhigh frequency equipment involves increased power and improved reliability standards for radio transmission and switching equipment. Because distortion occurs in coaxial switches in the transmission between stationary and fixed elements, a decimeter-range unit without direct contacts is considered. The switch consists of rotor and stator elements and has three inputs matched to three outputs by means of an electromechanical drive. Bridging occurs between stator and rotor without direct contact, across a gap which can be adjusted to required wavelengths. Tests for various switch combinations showed that in the range of 650-850 MHz the voltage standing wave ratio did not exceed 1.5 while the attenuation value was more than 27 dB. Dielectric strength was tested up to 1 kW and no breakdowns were observed. Figures 5; references: 2 Russian.  
[297-12497]

## COMMUNICATIONS

UDC 621.396.62

### NOISE COEFFICIENT OF MAIN LINE RADIO RECEIVERS WITH LARGE DYNAMIC RANGE

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 27 Sep 83)  
pp 42-43

TROITSKIY, B. S.

[Abstract] Main line radio receivers in the decimeter range require high sensitivity, selectivity and low noise and distortion. Designs involve several frequency conversions, quartz filters and p-i-n diode attenuators with a compromise between amplification and noise coefficients and dynamic range and linearity. The effect of the diode attenuator on noise is considered and it is found that in addition to thermal noise the diode which handles considerable current (5-30 mA) produces shot noise so that the total attenuator noise coefficient (two-element T-type) is 3-6 out of a total apparatus value of 6-10. The amplifiers make an equal contribution while the frequency converters have hardly any effect. The results are applicable to relay receivers and amplifiers and multichannel cable systems. References 8: 7 Russian, 1 Western.  
[297-12497]

### SEMINAR ON NATIONAL SATELLITE COMMUNICATION SYSTEMS IN SHANGHAI

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 pp 61-63

KRIVOSHEYEV, M. I.

[Abstract] In October 1983 a seminar on national satellite communication systems was held in Shanghai under the auspices of the International Telecommunications Union and the International Radio Consultative Committee (CCIR) as part of World Communications Year activities. A description was given of the 36 channel INTELSAT (International Telecommunications Satellite Consortium) system which now serves 23 countries and will be used by 45 by the end of the 1980's. Reports were given on planned or existing national systems by Australia, Japan, USA (with 5500 ground stations), Canada, India, China, France, Brazil, Italy and the regional European EUTELSAT and Arab countries' ARABSAT systems. Topics covered included INTELSAT technical

developments and relay leasing facilities, the planned Hughes small-scale satellite system for serving rural areas, the technology of a small Chinese 6-m antenna ground station compatible with INTELSAT, standardization of ground technology, modulation and multiplexing, antennas, propagation and noise, geostationary satellites and economic aspects of satellite technology. It was reported that China intends to lease INTELSAT facilities until it can create its own system and 38 ground stations will be developed.  
[297-12497]

#### IMPROVING UTILIZATION OF CALL-CONNECTION LINES

Moscow VESTNIK SVYAZI in Russian No 6, Jun 84 pp 37-38

KRIYEV, Yu. Yu., senior engineer, Riga Telegraph and Telephone Station

[Abstract] Each of the three methods of estimating the quality of long-distance telephone connections recommended by the International Telegraph and Telephone Consultative Committee has certain shortcomings: 1) Polling subscribers yields only generalized data; 2) Test and inspection dialing does not reveal the nature and the location of faults; and 3) Tracking actual calls does not reveal weak and wrong connections. In the Riga Telegraph and Telephone Station the number of failed connections, the principal indicator of service quality and line utilization, is therefore determined otherwise, namely by tracking the load and disconnections along each segment of the network in the course of test dialing. This is particularly important, because in the AMTS-2 automatic long-distance telephone station a high percentage of connections fails along the "intermediate register - automatic relay set - outgoing register - converter" segment of the call-connection line. A special device has been developed for establishing the cause of failures, no such device being included in standard AMTS-2 equipment. It automatically records pulses at the input to incoming connection lines and indicates the causes of connection failures on the basis of pulse distortions. Truncation of pulses, wide variation of pulse width, or vanishing of pulses are caused by contamination or poor adjustment of relay contacts, these causes being easily remedied. Truncation or vanishing of only the first pulse are caused by leakage paths around the intermediate register, which can also be readily eliminated. Inspection by this method has not only reduced the number of necessary repetitive tests but also improved the utilization of call-connection lines in automatic telephone stations as well as in automatic long-distance telephone stations.  
[309-2415]



CONSOLE MTA-15-2 FOR REMOTE INSPECTION AND MONITORING OF AUTOMATIC LONG-DISTANCE COIN-BOX TELEPHONES

Moscow VESTNIK SVYAZI in Russian No 6, Jun 84 pp 39-40

VOROTNOY, A. A., chief, Donetsk Telegraph and Telephone Station,  
ZIL'BERBORT, I. G., chief of production laboratory, KISLUKHA, V. A.,  
senior engineer, and MORGUNOV, M. S., chief of telephone call office

[Abstract] The operation of automatic long-distance coin-box telephones requires continuous monitoring by station technicians, the object being to minimize shutdown time and to detect faults prior to failure. An automatic console MTA-15-2 with a display screen has been developed for this purpose, in accordance with plans for scientific organization of labor, and is now installed in the Donetsk telegraph and telephone station. It can operate either automatically or semiautomatically. In the automatic mode the display screen will indicate jamming of a coin in the coin box or in the coin tester, loss of voltage in the booth, a break in the handset, open or short circuit in the cord, opening of the coin box or of the main compartment, a busy condition, and a permanent shutdown. In the semiautomatic mode the technician can monitor correct dialing, measure the duration and the period of billing pulses for a given zone, make toll-free connections between subscriber or field technician and serviceperson on duty in station, measure the dial parameters, connect subscriber to operator for assistance, and disconnect the booth set and dial from station to check the line. The console includes, in addition to the display screen, a switchboard, two generators of test pulses, a frequency selector, a control module, a count interrogation module, two interrogation and inspection modules, a module for measuring the parameters of connecting lines, a signalization module, an interrogation time counter, a message transmitter, a call transmitter, and a power supply. The console operates from a 24/60 V power supply, drawing a power of 240 W. It weighs 180 kg, and its components are built with series K155 microcircuits where appropriate. Use of this console in 1983 has reduced failures by 72% and has improved the profitability of coin-box long-distance telephones by 3%, with an annual saving of 8,367 rubles to the station. Figures 2.

[309-2415]

DYNAMIC CHARACTERISTICS OF CONTROL SYSTEMS WITH PULSE FREQUENCY MODULATION OF FIRST AND SECOND KINDS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 5, May 84 (manuscript received 23 Dec 82) pp 30-36

LOKHIN, VALERIY MIKHAYLOVICH, candidate of technical sciences, docent, senior scientific research worker, and MAKAROV, VIKTOR VLADIMIROVICH, junior scientific research worker, both from Moscow Institute of Radio Engineering, Electronics and Automation

[Abstract] A method of analyzing both steady-state and transient processes in control systems with pulse frequency modulation is described, applicable to integral modulation of the first kind

$$\int_{t_{i-1}}^{t_i} y(nT_p) dt = \pm \Delta, \text{ with an error}$$

signal measured at discrete equidistant instants of time and readings recorded during the intervals) and of the second kind

$$\int_{t_{i-1}}^{t_i} y(t) dt = \pm \Delta,$$

with an error signal measured continuously). The method is based on harmonic balance for a modulator consisting of an integrator, a nonlinear quantizer of signal level increments (threshold  $\Delta$  and step height  $\delta$ ), and a shaper of square pulses (duration  $\gamma$ ). Both systems are regarded as nonlinear ones with different normalized linear ranges. Their frequency characteristics and regulation characteristics are evaluated on the basis of the corresponding transfer functions, with harmonicity  $M$  and rank  $N$  characterizing the transient process. Limit circles and their envelope defining the stability limit in the  $U$ - $jV$  phase plane are calculated for various combinations of  $M = \text{const}$  and  $N = \text{const}$  values. The results are compared with oscillograms of the transient response. Figures 7; references: 5 Russian. [308-2415]

## ELECTROMAGNETIC COMPATIBILITY

### CONTENT OF COURSE ON 'ELECTROMAGNETIC COMPATIBILITY METHODS FOR RADIOELECTRONIC FACILITIES'

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 pp 59-60

BYKHOVSKIY, M. A. and KHOROSHCHANSKIY, V. Yu.

[Abstract] More stringent requirements for communications including radio, TV, space equipment, mobile units, etc. and the need for trained specialists make it necessary to introduce a course on communication compatibility into the university curriculum. Part 1 of the course will cover the foundations of electromagnetic compatibility, domestic and international frequency allocation (CCIR), and characteristics of users and bands with special attention to computerized frequency apportionment. Part 2 will deal with interference in analog and digital systems so that students can compute noise factors and design solutions. Part 3 will cover industrial interference problems and deal with noise in technical environments including the use of remote control equipment. The course is to follow radio design training and experts will be asked to write a textbook so that radioengineers will be prepared for practical work.

[297-12497]

UDC 621.395.345

USE OF MICROPROCESSORS IN CONTROL DEVICES OF SWITCH UNITS

Moscow ELEKTROSVYAZ' in Russian No 6, Jun 84 (manuscript received 24 Jan 82)  
pp 1-6

POPOVA, A. G. and KARASIK, M. M.

[Abstract] Microprocessors programmed on the modular concept with the formation of a series of functional loops are being used for the control of fully electronic systems and also to modernize older automatic telephone exchanges through the introduction of electronic signal and dialing reception units which scan incoming signals and respond. It is possible to use existing microprocessors such as the K580, K589 and K1801 as well as the serially-produced Elektronika-60 minicomputer. The control unit discussed uses the K580 and consists of the microprocessor with a working memory, 2 kbyte storage, timer and input-output connected by data busses to the switch unit which can simultaneously handle 8 calls, i.e., one of the N customer groups. Data inflow is handled by priority systems. Algorithms are given for loop programming and the unit can replace up to 60 subscriber registers and serve up to 2000 customers at high quality levels. Figures 7; references: 4 Russian.  
[297-12497]

UDC 681.325.3.087.92:621.3.019.3

DIGITAL ANGLE TRANSDUCER WITH MULTIPOLAR POLYPHASE ROTATING TRANSFORMER

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 7-9

SMIRNOV, V. I.

[Abstract] Multipolar rotating transformers with open construction are used for angle-to-code conversion in high-precision angle transducers. The error reduction factor can be further increased by the use of polyphase transformers of this kind, the angle error being reduced here by the factor  $i = mp$  ( $m$  - number of phases,  $p$  - number of poles). Another advantage of this

encoding method is a lower sensitivity to converter manufacturing imprecision and to operating conditions. The transducer on the basis of such a transducer requires a phase commutator, a signal sampling device and a signal storing device at the outputs of which the amplitudes of the a.c. signal appear, an amplifier-inverter for the stored signal, a linear digital-to-analog converter with reversible level counter, and a master oscillator which together with a comparator constitutes a converter of voltage ratio to code and together with the commutator and a reversible phase counter selects the operating phase pair. A particularly high sensitivity can be attained by use of a 309ID5 R-2R array in the digital-to-analog converter, the principal source of error, as has been demonstrated in a TsPU-M prototype angle transducer with  $q = 360/2mp^\circ$  scale divisions in the least significant bit. Figures 2; references: 3 Russian. [307-2415]

UDC 621.385.15

# SOLUTION OF MULTICHANNEL PROBLEM OF COMPUTER-AIDED DESIGN FOR INDUCTIVE ANGLE TRANSDUCER

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FLEKTROMEKHANIKA in Russian No 5, May 84 (manuscript received, after completion, 6 Dec 83) pp 74-80

VAGANOVA, MARINA YUR'YEVNA, candidate of technical sciences, senior scientific research worker, and DENISOVA, TAT'YANA SERGEYEVNA, candidate of technical sciences, senior instructor, Moscow Institute of Electronic Machine Design, ZADOROZHNIY, BORIS GRIGOR'YEVICH, sector chief, SAVEL'YEV, YURIY KONSTANTINOVICH, candidate of technical sciences, sector chief, and KHEMLININ, YEVGENIY GEORGIYEVICH, department chief, Moscow Institute of Electronics and Automation

[Abstract] An inductive angle transducer consisting of two wound stator cup cores and a solid rotor ring is to be designed for maximum restoring torque and minimum null signal, a null signal which moreover is to remain stable at a given steepness of the output signal. The null signal, which is principally a consequence of manufacturing errors, is a governing parameter from the standpoint of transducer sensitivity and reliability. The design of such a device is treated as a multicriterial optimization problem. The performance equation is formulated in terms of an impedance matrix and a winding connection matrix, on the basis of an equivalent electric circuit which accounts for magnetic reluctances and leakage permeances in the magnetic circuit. The corresponding design problem is solved for maximum steepness of the output signal and for insensitivity of the null signal to changes in design or performance parameters. The nine independent variables selected are the number of winding turns, width of air gap, distance from center of transducer to center of stator structure, radius of inner stator cylinder, radius of outer stator cylinder, height of both cylinders, height of yoke, height of rotor, and input voltage. The eight constant parameters

selected are the outside diameter of transducer, height of insulated winding, clearance between insulated winding and inner cylinder, clearance between insulated winding and outer cylinder, copper filling factor in stator groove, iron stacking factor in stator core, and equal resistances of both bridge circuits. Solution of the problem includes search for the global extremum of the target function and return into the permissible range by zig-zag motion along the boundary of constraints after the latter has been exceeded. The algorithms are formalized into the respective flow charts and programmed for a computer. Numerical experiments for a typical transducer yielded three design variants comparable with the existing design. One of them is best under a rigidly fixed input voltage. The others may be preferable depending on the ranking of the performance criteria with respect to importance. Figures 4; tables 1; references: 5 Russian.  
[308-2415]

## INSTRUMENTATION AND MEASUREMENTS

UDC 389.14:620.179.16:62-462

### STATUS OF METROLOGICAL PROVISION FOR ULTRASONIC DEFECTOSCOPY OF PIPES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 p 5

VIT'KO, P. I., SHKARUBSKIY, Ye. I. and KREPAK, I. I.

[Abstract] Ultrasonic equipment available at the Nikopol' Southern Pipe Manufacturing Plant consists of instruments for measuring physical quantities in normative units within specific accuracy and flaw detectors with accessories, both groups including equipment produced by foreign manufacturers. Major accessories are scanners, mechanical linkages, electrical circuits, transducers and etalons. Means are also available for inspection and maintenance according to a procedure based on binary logic "go" ("0") - "no go" ("1") and implemented under heavy loading along a continuous curve. Four refinements of this procedure are proposed: 1) Flaw detectors TUK-3 and TUK-4, not subject to governmental inspection now, ought to be periodically checked against applicable GOVERNMENT STANDARDS; 2) Flaw detectors operating under conditions other than during calibration ought to be treated as nonstandard instruments and checked accordingly; 3) Electronic components used for purposes other than estimating magnitudes in units of physical quantities within normative accuracy ought to be checked not governmentally but departmentally by the metrological service; 4) Departmental inspection and repair procedures including maintenance schedules, also production of test specimens and converters for electrical quantities ought to be formalized legally. References: 5 Russian.  
[307-2415]

# DEVICE FOR CONTACTLESS MEASUREMENT OF LINEAR DIMENSIONS WITH USE OF SIGNAL SHAPER MATRICES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 10-11

SKRIBANOV, Ye. V., ALEKSEYEV, K. B., MARKIN, S. V. and MATVEYENKO, V. I.

[Abstract] A device has been developed for contactless measurement of linear dimensions of parts within the  $\pm 0.6$  mm range within a  $\pm 0.005$  mm accuracy, using an array of video pulse shapers. Its advantages over existing devices for such measurements with conversion of video signals by cathode-ray vacuum tubes are smaller size, lower supply voltage, and elimination of time coding. It consists of an instrument transducer and a signal processing logic, the former including an Al042 optical measuring channel, a control module, and a video amplifier. The optical measuring channel includes a photosensitive accumulator array of 144 lines with 232 cells per line, a memory consisting of 144x232 cells, and output register consisting of 232 cells. The control module consists of two special-purpose LSI chips: an Al057 8-MHz master oscillator which generates nine sequences of storage and transfer pulses, and an Al058 set of nine level shapers. The device operates in the push-pull mode, receiving information-carrying video pulses during pauses between frame synchronizing pulses. The latter trigger the processing logic, which consists of six AND gates and two OR gates, while line synchronizing pulses are involved in frequency division. This operation requires two servo multivibrators, seven triggers, five counters, and one output decoder feeding the 3-digit luminous display panel. Figures 3; references: 1 Russian.  
[307-2415]

UDC 389.14:621.373:621.378.325

# METROLOGICAL PROVISION FOR MEASUREMENT OF RELATIVE ENERGY DENSITY DISTRIBUTION OVER BEAM CROSS SECTION AND OF BEAM DIVERGENCE IN PULSE LASERS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 13-14

KOTYUK, A. F., KORSHIKOV, V. B., STEPANOV, B. M., TIKHOMIROV, S. V. and YAKOVLEV, V. A.

[Abstract] Etalons for pulse lasers and radiators with normative relative energy density distribution over the beam cross section have been developed and built for inspection at both governmental and industrial levels. The special governmental etalon of unit energy density distribution consists of a supply and control system, an instrument laser, a monitor of radiation parameters, a receiver, a testing and certification system for coordinate-sensitive materials, and a data processing system. The normative relative energy density distribution is converted into a smooth bell function by means



of an apodized diaphragm, the latter having a definite transmission characteristic and being placed inside the laser resonator cavity. This diaphragm is formed by two total-reflection prisms joined at their hypotenuse facets through a gap of piezoceramically controllable width, the hypotenuse facet of one prism being flat and that of the other prism being spherical. Single-mode radiation enters the diaphragm in pulses with quasi-plane fronts, while a uniform pumping field is produced by stable interference mirrors consisting of reflective films on substrate wedges. The monitored radiation parameters include pulse duration and pulse form as well as laser beam divergence and energy, the latter being determined calorimetrically with an energy reference standard and with a photoelectric converter. The receiver consists of a long-focus (1600 mm) objective, a specular light-splitter wedge, and a "Zenit-V" photographic camera. The accuracy of thus reproducing an energy density distribution unit has been analyzed and evaluated in terms of standard deviation and nonremovable systematic error, the latter having three components associated respectively with the optical density of the photographic film, measurement of the energy density distribution curve at the lower end of the dynamic range, and discretization of the photometric field. Figures 2; references: 4 Russian.  
[307-2415]

UDC 621.384:621.378.325

# MULTICHANNEL COMMUTATORS OF ANALOG SIGNALS FOR MEASUREMENT OF ENERGY DISTRIBUTION OVER BEAM CROSS SECTION OF PULSE LASER

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 14-16

KUZNETSOV, A. A.

[Abstract] Instruments for measuring the energy distribution over the beam cross section of a pulse laser are checked against standards which include a primary instrument transducer, usually of the magnetic type, in the etalons as well as in reference and operating meters. Measurement of the energy distribution in the case of monopulse lasers with nonreproducible process characteristics and unknown space distributions requires a sufficiently wide dynamic range, inasmuch as measurement of a total energy  $10^{-5}$ - $10^6$  J at any point within that range must yield the relative energy distribution over the 1.0-0.01 range within 5-20% accuracy. Correspondingly, the commutator of signals must have a dynamic range of 55-65 dB. Existing multichannel commutators of analog signals (F7100, F799, KD-256, KD-400) are inadequate for this application. A comparative design and performance evaluation of special-purpose multichannel commutators for this application reveals that electromechanical ones such as ShI relays are superior in terms of low bias voltage with contactors closed, high ratio of "open" resistance to "closed" resistance, small temperature drift, wide dynamic range, low crosstalk level, and high stability, while contactless ones such as optrons or transistor-diode switches excel in high speed. Accordingly, one or another type of commutator must be selected and design for a given energy distribution measuring instrument,

also taking into account the required precision and sensitivity of digital voltmeters used with these instruments. Figures 1; tables 1; references 12: 11 Russian, 1 Western.  
[307-2415]

UDC 621.316.56.027:621.373.826

400-CHANNEL COMMUTATOR FOR MEASUREMENT OF ENERGY DISTRIBUTION IN LASER BEAM

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 16-18

CHEREUGIN, V. L. and KUZNETSOV, A. A.

[Abstract] An experimental study of a 400-channel commutator for measurement and analysis of the energy distribution over the beam cross section of pulse lasers was made for the purpose of evaluating its performance characteristics. This commutator transfers electric signals sequentially from 400 channels to the input of a digital high-precision voltmeter, signals of a magnitude ranging from a few microvolts to tens of volts and remaining constant during the switching period. Each commutator element is a step-by-step switch and the effect of its performance on the accuracy of voltmeter readings depends on the switching cycle as well as the commutation characteristics. These were tracked through a set of three relays and a ShCh68003 digital voltmeter continuously selecting one of two strobe signals. The voltmeter readings were analyzed by equipment including a start-stop cycle setter, a shaper of control pulses for a control module, with two amplifiers and two commutator control windings, and were also printed out after passage through a matching circuit. Calculations based on the voltmeter output data and on the equivalent electrical circuit of the commutator elements, with a high ratio of "open" resistance to "closed" resistance, yield an error of  $5 \cdot 10^{-4}$ – $5 \cdot 10^{-3}$  at temperatures of 20–65°C for one channel operating alone with crosstalk from the other 399 channels. Figures 3; references: 8 Russian.  
[307-2415]

## DEPENDENCE OF ERROR OF MEASUREMENT OF RELATIVE ENERGY OR POWER DENSITY DISTRIBUTION OVER CROSS SECTION OF LASER BEAM ON SPACE FACTOR OF MULTIELEMENT RADIATION TRANSDUCER

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 18-19

ZAGORSKIY, Ya. T. and KARABAK, Yu. V.

[Abstract] Measurements of the relative energy or power density distribution in a laser beam with an instrument including a multielement radiation transducer contain an error which depends on many factors. One component of this error, unlike of the error in the case of the absolute energy or power density distribution, is associated with the degree of area discretization in the diaphragm in the field of vision. This error component depends on the relative energy or power density distribution in the laser beam and on the number of sensor elements in the transducer as well as on their shape and their spacing density over the receiver surface. The relation is established analytically for the general case of an n-element radiation transducer feeding output signals through a commutator or to an analog-to-digital converter. Numerical calculations for three different forms of radiation transducer, with  $n = 900$ , 256, 100 respectively, reveal that a decrease of the spacing density of sensor elements will decrease the energy or power at the transducer input and increase the error introduced by the analog-to-digital converter, and that an increase of the number of sensor elements otherwise under the same conditions will also increase this error. Figures 3; references: 2 Russian. [307-2415]

## PHOTOELECTRIC INSTRUMENT FOR MEASURING RELATIVE ENERGY DENSITY DISTRIBUTION IN BEAMS OF PULSE LASERS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 21-22

ARBKOV, V. I., ULANOVSKIY, M. V., ZAGORSKIY, Ya. T., LEVI, A. M. and GLAZOV, A. I.

[Abstract] The relative energy density distribution over the beam cross section of pulse lasers can be measured with both high space resolution and high accuracy when a photoelectric transducer array is used for this purpose. Such a transducer combines high sensitivity with a wide dynamic range. Its photoreceiver stage is preceded by a fiber-optic light collector and is followed by an integrator feeding into an analog memory. Both integrator and memory are energized from a power supply controllable by a multichannel commutator with analog-to-digital and digital-to-analog conversions. Use of fiber optics allows spacing of the transducer components so as to almost completely eliminate any coupling between channels. The spectral range of

the light collector is 0.4-2.0  $\mu\text{m}$ . The photoreceiver consists of commercially produced FD-8K silicon photodiodes, each serving as a current generator and loaded by the input impedance of the operational amplifier built with K544UD2A microcircuits which converts each photodiode current into a voltage proportional to the radiation pulse energy. The analog memory consists of two operational amplifiers and a diode-capacitive factor and with discretization of a radiation pulse into 256 measuring channels, relative energy density distributions over the 0.01-1 range can be measured with an acceptable error not exceeding  $\pm 20\%$  where the energy density reaches up to  $1.5 \text{ J/cm}^2$  in radiation pulses of  $10^{-8}$ - $10^{-6}$  s duration. Figures 3; references: 2 Russian.  
[307-2415]

UDC 681.118.1:631.3:389.21

#### IMPROVING ACCURACY OF COMPUTER-GENERATED TIME SCALES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 25-27

AGAFONOV, V. S.

[Abstract] Computer networks spread over a wide territory require accurate recording and transmitting of time information, outstanding examples being the launching of space vehicles and the startup of a power reactor. A series RYaD-1 computer of the YeS system generates the necessary time scale according to a program, with a 32-bit word at the address 80 in the main memory serving as a timer. A unity is subtracted from bits 21 and 22 at a repetition rate equal to the line frequency of 50 Hz, namely every 20 microsecond. A call for interruption comes through as soon as the continuously decreasing number in the timer becomes negative, whereupon the program supervisor appropriately manipulates both the pseudoclock and the calendar stored in the computer memory. The accuracy of the time scale thus generated depends foremost on the accuracy with which the pseudoclock has been set initially according to the operator's watch. In a series RYaD-2 computer the accuracy of the time scale has been improved by installing, in addition to two timers, an independently operating astronomical clock. The latter, in the form of a 64-bit register, is connected to the 1 MHz output of a frequency divider with a 2 MHz input. The accuracy of the time scale can also be improved in a series RYaD-1 computer, namely by a more accurate initial setting of the pseudoclock and by reduction of the drift. This is done by using an external time scale generator rather than hour or five-minute marker signals. It requires a supplementary buildup of the computer facility, however, which is not always feasible. Using a code rather than time marker signals overcomes this difficulty, inasmuch as only the computer software rather than the computer hardware needs to be expanded and a standard interface with an adapter will be adequate. A similar technique is applicable to modular computer systems and systems of SM-1,2 or SM-3,4 small computers. References: 4 Russian.  
[307-2415]

## PECULIARITIES OF USING RADIO NAVIGATION SIGNALS FOR REGULATING MOVEMENT OF TRAINS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 27-28

APTER, B. F., DAVYDOV, B. I. and PROKOPOVICH, M. R.

[Abstract] The problem of tracking the location of trains and regulating their movement along railroad tracks can be treated as a problem of optimization with respect to range and accuracy, a range of 2000 km and an accuracy within 0.2-1 km being desirable targets. The problem of locating a train or unit of rolling stock can be solved with already available railroad facilities and addition of standard complementary equipment at points at least 300 m apart, which requires huge expenditures, or by fundamentally different methods already used in other transportation systems. Considering the latter alternative, radio navigation with a system analogous to LORAN C appears to be most expedient in terms of reliability. Distance-difference finding with long-wave loran signals should ensure reliable monitoring of trains within a radius of 200 km from the traffic control room, accurately within  $\pm 30$  m and with a cost saving of approximately US\$ 200,000 annually per control room and thus per circular territory of 200 km radius. The feasibility of using such a system for railroad traffic control depends, however, on several factors characterizing this mode of transportation and distinguishing it from sea or air transportation. The major factors are proximity of industrial facilities constituting sources of interference signals and unevenness of the ground surface. Other factors are the territorial layout of track networks, the type of traction, and the spacing of loran transmitters. An experimental study of all these factors was made for design purposes, with a loran operating at a frequency of 100 kHz along approximately 2000 km long segments of the Far-Eastern and Baykal-Amur railroad lines. Special instruments had been developed and built for picking up signals from trains standing still or in motion. The results reveal that even strong interference does not appreciably influence the readings of coordinates, most interference coming from the locomotive in the form of pulses repeating at a rate of 100 Hz with "clear" intervals of 1 ms duration between them and shifting in time because of fluctuations of the nominally 50 Hz industrial frequency. This interference is easily compensated in the receiver anyway. The receiver antenna on an electric locomotive must be of the magnetic rather than rod type, for safety reasons, so that the electric component of an electromagnetic wave will not be picked up. Train movement control by means of a LORAN C system can be either autonomous, each locomotive being equipped with a computer and an indicating device, or centralized with a single computer in the control room only. Figures 3; references 3: 2 Russian, 1 Western.

[307-2415]

## ESTABLISHMENT AND USE OF TIME UNIFICATION SYSTEM FOR CIVIL AVIATION

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 28-30

MALYY, M. M.

[Abstract] Precise and fail-proof operation of the various services used by civil aviation throughout the territory of the USSR depends largely on synchronization, the latter requiring periodic indication of time scales and involving the concept of time unification. The principal users of a time unification system are the traffic control service and the flight crew. Since 1974 electromechanical hand-and-dial clocks in airports have been gradually replaced with modern 15E165 "Signal" clocks, and these are being further improved by addition of various features such as automatic tie-in with the State Time and Frequency Service for checking and correction. Installation of secondary clocks in control towers, time encoding in the secondary clocks, and interfacing the clock room with the computer of the appropriate automatic control system are improvements made in the control tower. Meanwhile, time indicating and time keeping equipment is also installed in airplanes for tie-in with airports by means of radio signals over metric-wave or decametric-wave communication channels. All activities concerning establishment and use of the time unification system are coordinated by the appropriate State Commission which also deals with standard reference frequencies, the objective being to produce the necessary short-range radio navigation system with the inclusion of satellites for transmittal of unified time information from airports to airplanes and to produce equipment characterized by satisfactory technical accuracy and high stability with means for automatic or semi-automatic time correction guaranteeing high reliability for a period of 10 years.

[307-2415]

## TECHNICAL AND ECONOMIC REQUIREMENTS FOR TIME UNIFICATION SYSTEM SERVING MARITIME TRANSPORT VESSELS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 30-31

TETYUYEV, B. A.

[Abstract] On maritime transport vessels, particularly on passenger ships which often have many watches aboard, time is kept nowadays by means of mechanical chronometers of first-class and second-class accuracy. Because of their low accuracy, electrical clocks are unsuitable for this purpose and also not as frequency standards for automation systems on shipboard. An electronic time unification system is most appropriate, such a system consisting of a primary electronic clock and a secondary electronic clock as

well as a main control panel on the deck bridge and a central control panel in the engine compartment. The maritime fleet urgently needs such a system, inasmuch as without one each ship must carry its own frequency standard. The system should be designed for normal operation under all possible climatic and mechanical conditions. It must provide means for: 1) centralized keeping of two standard time scales shifted from one another by a whole number of hours (e.g., local time and Moscow time) in the primary clock; 2) transmission of time to two secondary clocks and displaying it in hours-minutes-seconds on a 6-digit dial and in hours-minutes on a 4-digit dial, respectively; 3) generating the time information on demand in the parallel binary-decimal 8-4-2-1 code; 4) generating time marker signals in 0.01, 0.1, 1, 60, 3600 s intervals on the time unification scale; 5) generating special signals in communication with automatic equipment on shipboard; and 6) automatic or manual correction of the primary clock without stopping the latter. The system must have a life of 10 years and be capable of operating for 5000 h without re-adjustment, with a mean diurnal drift not exceeding  $\pm 0.5$  s when operating with a built-in oscillator whose drift does not exceed  $\pm 0.1$  s, and with the initial reading accurate within 0.2 s. The system must be designed for a 200 V ~ 50 Hz shipboard power supply. It must also include a 24 V d.c. standby power supply for the primary clock, a corrector for the primary clock, two repeaters on the main ship panel, and six auxiliary repeaters. There should be at least two secondary clocks. Figures 2; references: 2 Russian.  
[307-2415]

UDC 621.753.1:535.5.069.6:519.21

#### MEASUREMENT OF VELOCITY OF OBJECT MOVING NEAR LARGE REFLECTING SURFACE

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 34-35

KSENZENKO, A. Ya.

[Abstract] Velocity measurement with a portable Doppler meter at radio frequencies is evaluated from the standpoint of range and accuracy, specifically in the case of an object such as an automobile moving at a low altitude above and parallel to a road which constitutes a long reflecting surface. The instrument case contains the transmitter and the receiver so that both can be regarded as being located at the same point. In addition to the main signal which has traveled along the Doppler(transmitter)-object-Doppler(receiver) path, stray components appear in the receiver which have traveled three other paths (Doppler-object-surface-Doppler, Doppler-surface-object-Doppler, Doppler-surface-object-surface-Doppler), components reflected by extraneous stationary objects, and one component transferred from transmitter to receiver directly inside the instrument case. The analysis is based on Doppler theory, including the indeterminacy principle, and yields the resultant error caused by all these interference signals. An experimental study made at the 10,525 MHz frequency has revealed several other factors causing deviations from theory,



the most significant ones being nonideal scattering by the object and unevenness of the surface. Beats produced by stray components also severely limit the accuracy of Doppler velocity measurements. Figures 3; references 7: 6 Russian, 1 Western.  
[307-2415]

UDC 621.384.3:536.52:53.089.6

REFERENCE SET FOR CALIBRATING CRYOGENICALLY COOLED RECEIVERS OF LOW-DENSITY RADIANT THERMAL FLUXES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 37-39

KISELEV, S. B., TKACHENKO, S. A. and EL'DAROV, F. G.

[Abstract] A reference set for reproducing the integral energy density of radiant thermal fluxes over the  $10^{-11}$ - $10^{-5}$  kW/cm<sup>2</sup> range has been built at the All-Union Scientific Research Institute of Physicotechnical and Radiotechnical Measurements (VNIIFTRI) to serve as a means of calibration and standardization. This UVIPI-01 set is equipped for measuring the threshold sensitivity, the time constant, and the absolute absorption coefficient which characterize cryogenically cooled receivers of low-density infrared radiation in the presence of controllable background radiation. The set consists of a radiation source simulating a perfect black body, with interchangeable diaphragms, a modulator disk driven by an electric motor, an electromagnetic tachometer feeding reference signals to a synchronous detector, a cylindrical shield producing background radiation and a metal base with temperature regulation inside the shield serving as thermostat, all inside the vacuum jacket of a liquid-helium cryostat. Temperatures are measured with resistance-type reference thermometers TSPN-3, TSU-1, TSG-2 in a potentiometer circuit with automatic temperature regulation: temperature of the black body over the 10-300 K range, temperature of the shield over the 4-70 K range, temperature of the base over the 4-20 K range, and the error of all measurements not exceeding  $10^{-2}$ K. The frequency of radiation modulation by the rotating disk can be varied from 0 to 1000 Hz by varying the disk (motor) speed through voltage control. The source of systematic error is the black body, i.e., its deviation from Planck's law and the inaccuracy of its apparent emission coefficient and emissivity. The emissivity of the shield and the emissivity of the base were calculated on a computer independently by two methods, variational and Monte Carlo, disregarding diffraction by diffusely emitting surfaces. They also have been measured and the maximum discrepancy does not exceed 0.3%, which confirms the accuracy of both calculations and the insignificance of diffraction. The sources of random errors are all temperature measurements, imprecise dimensions of the diaphragms, imprecise location of the tested receiver, and nonuniform thermal flux distribution over the receiver surface. The overall error does not exceed 5%. Tables 2; references 10: 5 Russian, 5 Western (3 in Russian translation).  
[307-2415]



## METHOD OF MEASURING EMITTANCE OF THERMAL INSULATION MATERIALS AT LOW TEMPERATURES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 39-40

PADERIN, L. Ya., BASKIN, I. M. and FILIN, Yu. V.

[Abstract] The main difficulty in measuring the emittance of thermal insulation materials at temperatures below 500 K, namely interference from background radiation, has been overcome in an experimental test stand consisting of a vacuum chamber with a mechanism which rotates the test specimen inside. The specimen in the form of a flat disk is held firmly in a retainer fastened to the lower end of the vertical motor shaft. The temperature of the specimen is regulated by a cooler and a disk of conducting material with a controllable heater between them, the metal disk ensuring that the surface of the insulation material remains isothermal. Both the cooler and metal disk are eccentric relative to the axis of rotation so as not to obstruct the path for the radiant flux from the specimen surface through holes in the retainer to the radiation receiver underneath. Temperature and radiant energy are measured under a pressure not exceeding  $10^{-2}$  Pa, whereupon the emissivity is calculated according to the Stefan-Boltzmann law. There are two main systematic errors in the emissivity readings. The source of one error is reflection of the radiant flux into the receiver by "hot" components of the apparatus, including the test specimen. The source of another error is cooling of segments of the specimen surface as the rotating specimen passes through the cold "zone" between shield and radiation meter. The first error depends on critical geometrical dimensions, which also determine the angular coefficient of radiative heat transfer, and also on the speed of rotation. Calculations for the two extreme cases of diffuse reflection and specular reflection indicate that this error of emissivity reading can be held below 0.015 by design. The second error has been estimated by numerical solution of the corresponding equation of two-dimensional transient heat conduction, assuming that it does not exceed 0.25 and depends on the sensitivity of the radiation meter. The two errors are in opposite directions and, therefore, compensate one another to a large extent. Figures 3; references 9: 8 Russian, 1 Western (in Russian translation).

[307-2415]

## MAGNETOOPTIC TRANSFORMER OF LARGE ALTERNATING CURRENTS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 43-45

GLAGOLEV, S. F., ZUBKOV, V. P., CHERVINSKIY, M. M. and ARKHANGEL'SKIY, V. B.

[Abstract] A magneto-optic current transformer based on the Faraday effect is superior to an electromagnetic one when used over a wide current range from a few amperes to tens of kiloamperes, its main advantages being noninductiveness and complete isolation of the measuring instruments from the current-carrying bar. Such a transformer is proposed which has a gas laser as the radiation source and fiber optics for transmitting the radiation to a Faraday cell, the latter being placed at a high electric potential between a polarizer and a two-beam analyzer. Current is converted to an angle of rotation of the polarization plane. The analyzer, which is orthogonal to the polarizer with some inaccuracy, converts this angle into antiphase changes of two radiant fluxes which are each transmitted through fiber optics to a photoreceiver. Both photoreceivers and the gas laser are at a low electric potential. An objective lens before the entrance to the fiber optics focuses the laser radiation for transmission to the Faraday cell. An objective lens behind the exit forms a parallel light beam in the Faraday cell. Influence of stray magnetic fields and thermal effects are eliminated by closing the Faraday cell, a ring formed by four diamagnetic glass rods, around the current bar. The multiplicative error caused by variation of the radiant flux and of the photoreceiver sensitivity is eliminated by including a voltage amplifier with gain control in addition to the photoflux amplifier in each of the two photoreceiver channels. The performance of this device has been evaluated on the basis of the circuital law with Verdet's constant as an angle-to-current conversion factor and Malus' law for a differential circuit. Errors caused by imprecise analyzer setting and null drift in the photoflux amplifiers as well as the static error of automatic control are easily eliminated by adjustment. There remain errors of current measurement, a multiplicative one caused by temperature variation and not larger than  $3 \cdot 10^{-4} \Delta T_t$  ( $T_t$  - temperature of photoflux amplifiers) as well as an additive one caused by noise in the gas laser and in the photoreceivers. With the nonremovable residual noise in the gas laser equal to approximately 1 A, the total additive error does not exceed 13.7 A. Figures 1; references: 2 Russian.

[307-2415]

## PHASE CALIBRATOR FOR LOW AND INFRALOW FREQUENCIES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 47-48

SAPEL'NIKOV, V. M. and MUFTAKHOV, A. M.

[Abstract] A phase calibrator for low and infralow frequencies is described, which uses the digital approach, with digital-to-analog converters for simulation and approximation of the output signal. It forms three sinusoidally stepped voltages, one of them a reference voltage and the phase shifts of the other two varying so that the phase difference between the two voltages remains constant. The device also includes a tunable generator of clock pulses, a code converter and a Kipp oscillator controlling the most significant digits of phase shift quantization, a reference-phase channel and two variable-phase channels, a code-to-phase shift converter, and two low-pass filters for extracting the fundamental components from the output voltages. Each of the three phase channels consists of a counter, a reference-voltage generator, and a digital-to-analog converter. The code-to-phase shift converter consists of three adders. The summation error depends on the law of variation of the phase quantization coefficients, this error being only  $4 \cdot 10^{-4}\%$  maximum for a  $10^\circ$  quantization step and linear variation of the coefficients. The calibrator is suitable for a 0.4-10 V range of output voltage and a  $0-359.9^\circ$  range of phase difference, with a  $0.05^\circ$  error of phase difference setting. Figures 1; references: 4 Russian. [307-2415]

UDC 621.317.373(088.8)

## PHASE METER WITH MICROPROCESSOR FOR SIGNALS WITH DISTORTED WAVEFORM

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 5, May 84 pp 48-49

PAN'KO, S. P., TKACH, V. I. and CHMYKH, M. K.

[Abstract] A phase meter with a microprocessor is described which measures phase shifts between signals with distorted waveform. The microprocessor executes the algorithm of discrete-orthogonal processing with a fixed number of readings within a given frequency range and the trigonometric coefficients calculated a priori for storage in the read-only memory. An alternate method would be to process an arbitrary number of readings and to calculate the trigonometric coefficients for each frequency in the measurement. The microprocessor consists of a sampling and storing device, a reference-signal shaper, a readout-pulse shaper, a digital frequency multiplier, an analog-to-digital converter, a control unit, an accumulator, an interface built with K580IK55 LSI microcircuits, a read-only memory with a data bus and an address bus, an external interface control, an interface indicator, a record-read communication line, and a microcomputer with direct-access memory. The

experimental prototype of this phase meter has a frequency range from 10 Hz to 6 kHz with an expansion to 100 kHz, a dynamic range from 5 mV to 0.5 V, a fundamental error phase reading not larger than  $0.2^\circ$  and 2nd to 14th harmonics with 100% coefficients and a phase sensitivity of  $0.01^\circ$ . Figures 1; references: 3 Russian.  
[307-2415]

UDC 621.317.6:621.35:621.38

#### INSTRUMENT FOR TESTING DISCRETE ELECTROCHEMICAL INTEGRATORS

Moscow IZMERITEL'NAYA TEKHNICA in Russian No 5, May 84 p 53

SHEPELEVSKIY, L. Yu. and YARYGIN, A. S.

[Abstract] In order to extend the usefulness of discrete electrochemical integrators, which operate on the basis of metal dissolution and precipitation, it is necessary to test them comprehensively for reliability and the available performance margin. Existing test stands are inadequate inasmuch as they lack full automation of measurements, fault protection, and charge-discharge cycle counters. An instrument has, therefore, been developed and built which includes all these facilities. It contains the necessary charge-current and discharge-current generators, controlled pulse and timing generators, comparators, counters, frequency divider and decoder, coincidence circuit and switching logic, digital and alarm indicators, and an interlock. The current generators as well as the comparators and the interlock are built with series 284 integrated microcircuits, the current generators using C2-29 precision resistors with a very low temperature coefficient, while the digital components and the logic elements are built with series 155 integrated microcircuits. The instrument can be set independently for stable charge and discharge currents at 10 discrete levels within  $\pm 0.1\%$  from 30  $\mu\text{A}$  to 10 mA each, this range being extendable in both directions. The charge time can be set anywhere from 1 to 99999 s in 1 s steps and the discharge time can be set at up to 999,999.9 s. The cutoff voltage can be set within the 300-900 mV range in 100 mV steps. The instrument draws a power of not more than 50 W from a 200 V - 50 Hz line and operates satisfactorily at ambient temperatures from  $-35^\circ\text{C}$  to  $+10^\circ\text{C}$  under  $760 \pm 30$  mm Hg pressure with not more than 90% relative humidity. Two specimens of this instrument have already been successfully used in the industry for several years. Figures 1; references: 1 Russian.  
[307-2415]

## MAGNETORESISTIVE TESLAMETER FOR STRONG MAGNETIC FIELDS

Moscow IZMERITEL'NAYA TEKHNICA in Russian No 5, May 84 p 54

KATS, L. I. and SOMOV, A. Yu.

[Abstract] Magnetoresistors made of an InSb-NiSb alloy are considered for a Hall-effect teslameter compensating bridge. One pair of arms across the battery is formed by plain resistors. The other pair of arms is formed by such magnetoresistors with the low-resistance NiSb needles in each oriented perpendicularly and parallel, respectively, to the measured magnetic field. Because the material of both arms is the same, a temperature change will cause equal changes of  $R_{B\perp}$  and  $R_{B\parallel}$  so that no difference signal will be read by the diagonally connected instrument in the absence of a magnetic field. In a magnetic field, however, resistance  $R_{B\parallel}$  will change much more than resistance  $R_{B\perp}$  and the instrument will give a reading theoretically proportional to the magnetic induction. For a practical application of this principle, these magnetoresistors are made of an eutectic InSb-NiSb alloy doped with Te to an  $n = 6 \cdot 10^{16} \text{ cm}^{-3}$  concentration of electrons with mobility  $\mu = 5 \cdot 10^4 \text{ cm}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$ . Meander ribbons of this material are cut from ingots by the electric-spark process. A prototype teslameter with such a bridge was built with a conventional F4354/1 instrument and tested in the "Solenoid" stand in the Laboratory of Strong Magnetic Fields at the Institute of Physics, USSR Academy of Sciences. Its readings are linear over the 3-15 T range and quadratic over the 0.03-1 T range. The scale can be switched (its six ranges are 0-0.03 T, 0.03-0.1 T, 0.1-0.3 T, 0.3-1 T, 1-3 T, 3-15 T) by changing the battery current correspondingly within the 0.5-60 mA range. Its temperature error is 0.15%/K in the 213-293 K range, 0.25%/K in the 293-313 K range, 0.4%/K in the 313-353 K range. Its response speed is 2  $\mu\text{s}$  or better, suitable for measurement of magnetic field pulses of duration longer than 10  $\mu\text{s}$ . Preliminary studies indicate the feasibility of using InSb-NiSb magnetoresistors for strong magnetic fields at temperatures in the 4.2-77 K range. Figures 1; references: 2 Russian. [307-2415]

UDC 534.8.08.389.14

## UNIVERSAL ACTIVE COMPENSATOR FOR SUPPRESSION OF NOISE AND VIBRATORS

Moscow IZMERITEL'NAYA TEKHNICA in Russian No 5, May 84 p 55

YELSUKOV, V. A., GOLOVNIN, P. A. and KRAMAROVSKIY, S. V.

[Abstract] Suppression of noise and vibrations by the active or compensation method involves use of an external force in phase opposition to the perturbation force. For a rotating electrical machine, where noise of magnetic origin appears in the air gap, the compensating magnetic flux is produced by negative

feedback which will cancel most of the "tooth" noise and mechanical vibrations of the iron structure without weakening the alternating component of the main magnetic flux. An electronic universal active compensator designed for such an application includes an accelerometer as a vibration transducer, a matching input amplifier with stepwise gain control (30-110 dB in 10 dB steps), a tuned amplifier, a phase inverter, an overload indicator, and a class B power amplifier. The input amplifier is built on two KP103K field-effect transistors in a K140UD1B microcircuit. The tuned amplifier consists of a repeater stage built on a KP103K field-effect transistor, a K140UD1B operational amplifier, and a Wien bridge with variable capacitance for a tuning range from 12 Hz to 10 kHz. The phase inverter consists of three phase shifting circuits, respectively for rough, fine, and precise phase regulation over the 0-360° range. The overload indicator is an AL101 light-emitting diode. The power amplifier consists of an amplitude regulator, two intermediate stages built on a KT814V transistor and on a KT814G transistor, respectively, and an output stage with three transistor pairs: a KT815G and KT816G pair operating as repeaters and two KT803A pairs amplifying the signal power during the positive half-cycle and during the negative half-cycle, respectively. An output signal of maximum amplitude is attained by raising the supply voltage for all three transistor pairs to +(40-45) V. Two D226 diodes suppress clipping distortion and two D242 diodes serve as overvoltage protection under an inductive load. Self-excitation is prevented by a choke coil of 15 turns wound on a toroidal ferrite core. Negative feedback in the amplifier is provided by two resistance dividers with a common resistor. The power amplifier is rated for 1 V input and 25-27 V rms output, delivering approximately 350 W to a resistive load of 3 ohms. Figures 1; references: 3 Russian. [307-2415]

MAGNETIZATION REVERSAL IN TRIAXIAL SINGLE-DOMAIN PARTICLES

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
in Russian No 5, May 84 (manuscript received 3 Mar 82) pp 5-8

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[Abstract] Magnetization reversal in triaxial single-domain particles of magnetically hard materials such as the 52K11F alloy for hysteresis motors is analyzed for engineering design purposes. Because the characteristics of such a particle are determined by the orientation of the magnetic moment vector relative to the vector of the external magnetic field, the dependence of this orientation on the magnitude and the direction of the latter as well as on the original orientation is established here. The relation of the energy of a particle with the corresponding magnetic crystallographic anisotropy serves as a basis. Calculations are made in a rectangular system of coordinates whose axes coincide with the three directions of easy magnetization. The relations thus obtained reveal three ranges of original angle between the magnetic moment vector of the particle and the intensity vector of the applied external magnetic field. When this angle is small, increasing the intensity of the external magnetic field will cause the magnetic moment vector to rotate toward the magnetic field vector. This process is reversible. When the original angle between the two vectors is within the intermediate range, reversible rotation of the magnetic moment vector will be followed by a jumpwise rotation. When the original angle between the two vectors is large, increasing the intensity of the external magnetic field will cause only one or two jumpwise rotations. Further calculations yield both critical original angles and the critical magnitudes of the external magnetic field at which jumpwise rotation of the magnetic moment vector will occur. Figures 3; references 2: 1 Russian, 1 Western.  
[308-2415]



## DETERMINING SPATIAL ORIENTATION OF AXES OF ELLIPTICAL MAGNETIC FIELD

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
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[Abstract] The rotating magnetic field in induction motors is often elliptical, because of asymmetry of the polyphase line voltages or structural asymmetry in the machine. For an accurate analysis of electromechanical energy conversion in such a machine, one must then take into account the ellipticity of the magnetic field with the attendant nonuniformity of saturation. A generalized two-field model of an induction motor is proposed for this purpose, with superposition of two mutually orthogonal elliptical pulsating fields in stator coordinates. The self-inductances and the mutual inductances can be subsequently calculated on this basis. The spatial orientation of the two ellipses, specifically of their axes, needs to be determined first and this is done here for the most general case of an asymmetric machine with  $m$  stator phases and  $n$  rotor phases under asymmetric input voltages. The magnetizing force of any stator phase and any rotor phase is calculated accordingly, then the resultant magnetizing force and its space distribution. The major axis and the minor axis of the resultant ellipse correspond to the direction of the respectively maximum and minimum magnetizing force. Numerical results converging after six iterations are shown for a machine with  $m = 3$  stator phases and  $n = 2$  rotor phases. Figures 1; tables 1; references 4: 3 Russian, 1 Western (in Russian translation). [308-2415]

UDC 538.311

## MAGNETIC FIELD OF EXCITATION WINDING IN EXPERIMENTAL CRYOGENIC TURBOGENERATOR

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
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pp 14-19

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[Abstract] The magnetic field of the excitation winding in a cryogenic turbogenerator is evaluated on the basis of experimental data pertaining to a 2 MW machine (Physicotechnical Institute of Low Temperatures, UkSSR Academy of Sciences, Kharkov: preprints No 14, 1977 and No 30, 1979). The



magnetic field distribution had been measured with 56 induction transducers mounted in three mutually orthogonal planes. Measurements were made with the superconducting excitation coils without a shield and with a ferromagnetic external shield. Without a shield, the emf of the transducers was recorded with a light-beam oscillograph and the amplitudes of its first harmonic were calculated from the oscillograms. From these data were then calculated the longitudinal profiles of the three components (radial, tangential, axial) of the first harmonic of magnetic induction, all referred to the radial component in the center section at a distance of 0.25 m from the axis as the base. Corrections were made for imprecise orientation of the transducers, with an error of approximately  $1^\circ$ . The data pertaining to the superconducting excitation coils with a shield were evaluated on an "Argus-500" computer. A comparison of theoretically estimated experimental error and calculation error indicates that the experimental error is consistently smaller, these estimates corresponding to the maximum discrepancy, so that the results of this experimental study appear to be reliable. Figures 3; tables 1; references: 16 Russian.  
[308-2415]

UDC 621.318.13:538.22

# REVERSIBLE COMPONENT OF MAGNETIC INDUCTION IN MAGNETICALLY SOFT MATERIALS DURING MAGNETIZATION REVERSAL

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
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[Abstract] The reversible component of magnetic induction in magnetically soft materials is evaluated as function of the magnetic field intensity. The analysis is based on two mechanisms operating during dynamic magnetization reversal: reversible movement of domain walls and reversible rotation of the magnetization vector within a domain. The material is assumed to be initially in a state corresponding to negative remanence and then magnetized by magnetic field pulses of various durations to various levels up to saturation in the positive direction with subsequent relaxation to a residual level, ensuring that the irreversible component of magnetic induction be the same after each pulse. The process corresponds to fourth and first quadrants of the hysteresis loop. Static characteristics are extended to dynamic conditions, also taking into account the distribution of magnetic induction over the volume of material with alternation of positive and negative maxima. Experimental data pertaining to 79 Moly Permalloy ribbon agree closely with theoretical calculations based on the Weiss model, which validates this

method of analyzing dynamic magnetization reversal. Figures 3;  
references 5: 4 Russian, 1 Western (in Russian translation).  
[308-2415]

UDC 621.3.042

EQUIVALENT-CIRCUIT CALCULATIONS FOR BUILT-UP MAGNETIC STRUCTURES BY PROJECTION METHOD

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA  
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pp 50-60

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[Abstract] An equivalent circuit for a built-up multishell magnetic structure is developed by the method of projection. Such a structure contains three kinds of elements: segments of ferromagnetic material and joints between them with nonlinear characteristics and air gaps with linear ones. The gist of this method is to satisfy at each step any one of Kirchhoff's laws as well as the relation between magnetic flux and magnetizing force, and then correcting the circuit on the basis of Kirchhoff's other law. The procedure is demonstrated on a rectangular frame which consists of several concentric layers separated by narrow air gaps with a center bar forming two symmetric windows, this bar being split longitudinally through the center by a narrow air gap. The algorithm of solving the systems of algebraic equations for both magnetic flux vector and magnetizing force vector is aided by matrix notation and an equivalent resistance grid. It includes the use of magnetization curves, piecewise linearized, one for the high-permeability core material and one for the low-permeability material of the joints. The eleven steps of this algorithm have been formalized in a flow chart and programmed in ALGOL-60 for "Minsk-22" or "Minsk-32" computers. Typical numerical results referring to the flux density distribution are identical to the results obtained for this example by the conventional method of linearization, within the limits of a  $10^{-4}$  calculation error. The results also reveal a large third harmonic in the flux density distribution in both frame and center bar. The author thanks Professor E. V. Kolesnikov for assistance and advice. Figures 10; tables 2; references: 5 Russian.  
[308-2415]

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